**Module-3**

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1. **LECTURE NOTES**

**INTRODUCTION:** The mean value theorem tells us (roughly) that if we know the slope of the secant line of a function whose derivative is continuous, then there must be a tangent line nearby with that same slope. This lets us draw conclusions about the behavior of a function based on knowledge of its derivative.

**2.2** **MATERIAL REMOVAL PROCESSES**

**2.2.1**  **Definition of ROLLES THEOREM**

Let f(x) be a function such that

(i). It is continuous in closed interval [a,b]

(ii). It is differentiable in open interval (a,b) and

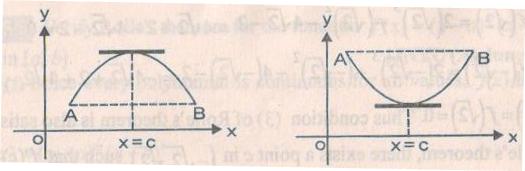
(iii). f(a) = f(b).

Then there exists at least one point ‘c’ in (a,b) such that f1(c) = 0.

**2.2.2 Geometrical Interpretation of Rolle’s Theorem:**

Let be a function satisfying the three conditions of Rolle ’s

Theorem. Then the graph.



1.y=f(x) in a continuous curve in [a,b].

2.There exist a unique tangent line at every point x=c, where a<c<b

1. The ordinates f(a), f(b) at the end points A,B are equal so that the points A and B are equidistant from the X-axis.
2. By Rolle’s Theorem, There is at least one point x=c between A and B on the curve at which the tangent line is parallel to the x-axis and also it is parallel to chord of the curve.

**2.2.3 Problems on Rolle’s theorem:**

**1. Verify Rolle’s theorem for the function f(x) = sinx/ex or e-xsinx in [0,π]**

**Sol:**i) Since sinx and ex are both continuous functions in [0, π].

Therefore, sinx/ex is also continuous in [0,π].

ii)Since sinx and ex be derivable in (0,π), then f is also derivable in (0,π).

iii) f(0) = sin0/e0 = 0 and f(π)= sin π/e π =0

 f(0) = f(π)

Thus all three conditions of Rolle ’s Theorem are satisfied.

There exists c є(0, π) such that f1(c)=0

Now 

f1(c)= 0 =>

cos c = sin c => tan c = 1

c = π/4 є(0,π)

Hence Rolle’s theorem is verified.

**2. Verify Rolle’s theorem for the functions in[a,b] , a>0, b>0,**

**Sol:** Let f(x) = ****

= log(x2+ab) – log x –log(a+b)

(i). Since f(x) is a composite function of continuous functions in [a,b], it is

continuous in [a,b].

(ii). f1(x) = 

f1(x) exists for all xє(a,b)

(iii). f(a) = 

f(b) = 

f(a) = f(b)

Thus f(x) satisfies all the three conditions of Rolle ’s Theorem.

So,  c  (a, b) f1(c) = 0,

f1(c) = 0, = 0  c2 = ab



Hence Rolle’s theorem verified.

**3. Verify whether Rolle ’s Theorem can be applied to the following functions in**

**the intervals.**

**i)f(x) = tan x in[0 , π] and ii) f(x) = 1/x2 in [-1,1]**

i). f(x) is discontinuous at x = π/2 as it is not defined there. Thus condition (i) of

Rolle ’s Theorem is not satisfied. Hence we cannot apply Rolle ’s Theorem

Rolle’s theorem cannot be applicable to f(x) = tan x in [0,π].

(ii). f(x) = 1/x2 in [-1,1]

f(x) is discontinuous at x= 0.Hence Rolle ’s Theorem cannot be applied.

**4. Verify Rolle’s theorem for the function f(x) = (x-a)m(x-b)n where m,n are positive**

**integers in [a,b].**

**Sol:** (i). Since every polynomial is continuous for all values, f(x) is also continuous

in[a,b].

f(x) = (x-a)m(x-b)n

ii).f1(x) = m(x-a)m-1(x-b)n+(x-a)m.n(x-b)n-1

= (x-a)m-1(x-b)n-1[m(x-b)+n(x-a)]

=(x-a)m-1(x-b)n-1[(m+n)x-(mb+na)]

Which exists

Thus f(x) is derivable in (a,b)

(iii) f(a) = 0 and f(b) = 0

f(a) =f(b)

Thus three conditions of Rolle’s theorem are satisfied.

There exists c є(a,b) such that f1(c)=0

(c-a)m-1(c-b)n-1[(m+n)c-(mb+na)]=0

 (m+n)c-(mb+na)=0

=> (m+n)c = mb+na

c = є(a,b)

 Rolle ’s Theorem verified.

**5. Using Rolle ’s Theorem, show that g(x) = 8x3-6x2-2x+1 has a zero between 0 and 1**

**Sol:** g(x) = 8x3-6x2-2x+1 being a polynomial, it is continuous on [0,1] & differentiable

on (0,1)

Now g(0) = 1 and g(1)= 8-6-2+1 = 1

Also g(0)=g(1)

Hence, all the conditions of Rolle’s theorem are satisfied on [0,1].

Therefore, there exists a number cє(0,1) such that g1(c)=0.

Now g1(x) = 24x2-12x-2

g1(c)= 0 => 24c2-12c-2 =0

c= c= 0.63 or -0.132

only the value c = 0.63 lies in (0,1)

Thus there exists at least one root between 0 and 1.

**6. Verify Rolle’s theorem for f(x) = x 2/3 -2x 1/3 in the interval (0, 8).**

**Sol:** Given f(x) = x 2/3 -2x 1/3

f(x) is continuous in [0,8]

f1(x) = 2/3 . 1/x1/3 -2/3 . 1/x2/3 = 2/3(1/x1/3 – 1/x2/3)

Which exists for all x in the interval (0,8)

f is derivable (0,8).

Now f(0) = 0 and f(8) = (8)2/3-2(8)1/3 = 4-4 =0

i.e., f(0) = f(8)

Thus all the three conditions of Rolle’s Theorem are satisfied.

There exists at least one value of c in(0,8) such that f1(c)=0

ie. => c = 1 є (0,8)

Hence Rolle’s Theorem is verified.

**7. Verify Rolle’s theorem for f(x) = x(x+3)e-x/2 in [-3,0].**

**Sol: -** (i). Since x(x+3) being a polynomial is continuous for all values of x and e-x/2 is

also continuous for all x, their product x(x+3)e-x/2 = f(x) is also continuous for

every value of x and in particular f(x) is continuous in the [-3,0].

(ii). we have f1(x) = x(x+3)( -1/2 e-x/2)+(2x+3)e-x/2

= e-x/2 [2x+3-]

=e-x/2[6+x-x2/2]

Since f1(x) doesnot become infinite or indeterminate at any point of the

interval(-3,0).

f(x) is derivable in (-3,0)

i) Also we have f(-3) = 0 and f(0) =0

f (-3)=f(0)

Thus f(x) satisfies all the three conditions of Rolle’s theorem in [-3,0].

Hence there exist at least one value c of x in the interval (-3, 0) such that f1(c)=0

i.e., ½ e-c/2(6+c-c2)=0 =>6+c-c2=0 (e-c/2≠0 for any c)

=> c2+c-6 = 0 => (c-3)(c+2)=0

c=3,-2

Clearly, the value c= -2 lies within the (-3,0) which verifies Rolle’s theorem.

**2.3. Lagrange’s mean value Theorem**

Let f(x) be a function such that (i) it is continuous in closed interval [a,b] &

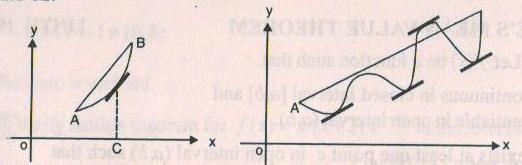
(ii) differentiable in (a,b). Then ∃ at least one point c in (a,b) such that

f1(c) = 

**Geometrical Interpretation of Lagrange’s Mean Value theorem:**

Let be a function satisfying the two conditions of Lagrange’s

theorem. Then graph.



1. y=f(x) is continuous curve in [a,b]

2. At every point x=c, when a<c<b, on the curve y=f(x), there is unique

tangent to the curve. By Lagrange’s theorem there exists at least one point



Geometrically there exist at least one point c on the curve between A and B

such that the tangent line is parallel to the chord 

**2.3.1Problems on Lagrange’s Mean Value Theorem**

**1. Verify Lagrange’s Mean value theorem for f(x) = x3-x2-5x+3 in [0, 4]**

**Sol:** Let f(x) = x3-x2-5x+3 is a polynomial in x.

It is continuous & derivable for every value of x.

In particular, f(x) is continuous [0,4] & derivable in (0,4)

Hence by Lagrange’s Mean value theorem ∃ c∈ (0,4) ∍

f1(c) = 

i.e., 3c2-2c-5 =  …………………….(1)

Now f(4) = 43-42-5.4+3 =64-16-20-3=67-36= 31 & f(0)=3

= 

From equation (1), we have

3c2-2c-5 =7 => 3c2-2c-12 =0

c =

We see that lies in open interval (0,4) & thus Lagrange’s Mean value

theorem is verified.

**2. Verify Lagrange’s Mean value theorem for f(x) =**  **in [1,e]**

Sol: - f(x) = 

This function is continuous in closed interval [1,e] & derivable in (1,e).Hence L.M.V.T is applicable here. By this theorem, ∃ a point c in open interval (1,e) such that

f1(c) = 

But f1(c) = 

c = e - 1

Note that (e-1) is in the interval (1, e).

Hence Lagrange’s mean value theorem is verified.

**3.Give an example of a function that is continuous on [-1, 1] and for which mean**

**value theorem does not hold with explanations**.

Sol:- The function f(x) = is continuous on [-1,1]

But Lagrange Mean value theorem is not applicable for the function f(x) as its derivative does not exist in (-1,1) at x=0.

**4.If a<b, P.T**  **using Lagrange’s Mean value theorem.**

**Deduce the following.**

i). 

ii). 

**Sol:** consider f(x) = Tan-1 x in [a,b] for 0<a<b<1

Since f(x) is continuous in closed interval [a,b] & derivable in open interval (a,b).

We can apply Lagrange’s Mean value theorem here.

Hence there exists a point c in (a,b)∍

f1(c) = 

Here f1(x) = 

Thus ∃ c, a<c<b ∍

 ------- (1)

We have 1+a2<1+c2<1+b2

 ……….. (2)

From (1) and (2), we have



or

………………(3)

Hence the result

**Deductions: -**

(i)We have 

Take & a=1, we get





(ii) Taking b=2 and a=1, we get







**5.Show that for any x > 0, 1 + x < ex < 1 + xex.**

**Sol:**  Let f(x) = ex defined on [0, x]. Then f(x) is continuous on [0, x] & derivable on (0, x).

By Lagrange’s Mean value theorem ∃ a real number c є (0, x) such that



………….(1)

Note that 0<c<x => e0<ec<ex( ex is an increasing function)

=>From (1)

=> x<ex-1<xex

=> 1+x<ex<1+xex.

**6. Calculate approximately  by using L.M.V.T.**

**Sol: -** Let f(x) = =x1/5& a=243, b=245

Then f1(x) = 1/5 x- 4/5& f1(c) = 1/5c- 4/5

By L.M.V.T, we have



=>

=>  (245) =f (243) +2/5c-4/5

=> c lies b/w 243 & 245 take c= 243

=> = (243) 1/5 +2/5(243)-4/5=

= 3+ (2/5) (1/81) = 3+2/405 = 3.0049

**7. Find the region in which f(x) = 1-4x-x2 is increasing &the region in which it is**

**decreasing using M.V.T.**

**Sol: -** Given f(x) = 1-4x-x2

f(x) being a polynomial function is continuous on [a,b] & differentiable on (a,b)

∀a,b∈R

f satisfies the conditions of L.M.V.T on every interval on the real line.

f1(x) = - 4-2x= -2(2+x)∀ x∈R

f1(x) = 0 if x = -2

for x<-2, f1(x) >0 & for x>-2 , f1(x)<0

Hence f(x) is strictly increasing on (-∞, -2) & strictly decreasing on (-2,∞)

**8. Using Mean value theorem prove that Tan x > x in 0<x<π/2**

**Sol: -** Consider f(x) = Tan x inwhere 0<<x<π/2

Apply L.M.V.T to f(x)

∃ a points c such that 0<<c<x<π/2 such that







But sec2c>1.

Hence Tan x > x

1. **If f1(x) = 0 Through out an interval [a, b], prove using M.V.T f(x) is a constant in that**

**interval.**

**Sol: -** Let f(x) be function defined in [a, b] & let f1(x) = 0 ∀ x in [a, b].

Then f1(t) is defined & continuous in [a, x] where a≤x≤b.

& f(t) exist in open interval (a, x).

By L.M.V.T ∃ a point c in open interval (a, x) ∍



But it is given that f1(c) = 0





Hence f(x) is constant.

**10 Using mean value theorem**

i) x > log (1+x) > x > 0



ii) π/6 + (/15) < sin-1(0.6) < π/6 + (1/6)



iii) 1+x < ex< 1+xex x > 0



iv) <tan(-1)v - tan(-1)u < where 0 < u <v hence deduce



1. π/4+ (3/25) < tan(-1)(4/3) < π/4+ (1/6)

**2.4 Cauchy’s Mean Value Theorem**  
 If f: [a,b] →R, g:[a,b] →R ∍ (i) f,g are continuous on [a,b] (ii) f,g are differentiable on (a,b)

****

****

**2.4.1:Problems on Cauchys mean value theorem:**

**1. Find c of Cauchy’s mean value theorem for**

** in [a, b] where 0<a<b**

**Sol: -** Clearly f, g are continuous on [a, b] ⊆ R+

We have  which exits on (a, b)

****

Also g1 (x)≠0, ∀ x ∈(a, b) ⊆ R+

Conditions of Cauchy’s Mean value theorem are satisfied on (a, b) so ∃c∈(a, b) ∍





Since a, b >0 ,√ab is their geometric mean and we have a<√ab <b

c∈(a,b) which verifies Cauchy’s mean value theorem.

**2. Verify Cauchy’s Mean value theorem for f(x) = ex& g(x) = e-x in [3, 7] &**

**Find the value of c.**

**Sol:** We are given f(x) = ex& g(x) = e-x

f(x) & g(x) are continuous and derivable for all values of x.

=>f & g are continuous in [3, 7]

=> f & g are derivable on (3,7)

Also g1(x) = e-x≠0 ∀ x ∈(3, 7)

Thus f & g satisfies the conditions of Cauchy’s mean value theorem.

Consequently, ∃ a point c ∈(3, 7) such that



=> -e7+3 = -e2c

=> 2c = 10

=> c = 5∈(3, 7)

Hence C.M.T. is verified

**2.5 TAYLOR’S SERIES :**

The series

is called **Taylor series expansion of** **of degree n about x = a** assuming that

f(x) hassuccessive derivatives of all orders for x

**2.5.1. 1).Obtain the Taylor’s series expansion of sin x in powers of**

**Sol:** Given that f (x) = sin x and

The Taylor`s series expansion of f (x) in powers of x – a is given by

here f(x) = sin x and a = π/4



Now differentiate f(x) w.r.t. x successively , we get

Hence the Taylor`s series expansion is





**2). Find the Taylors series expansion of sin2x about **

**Sol:** Write  = t + t

 Sin2x = Sin2(  + t ) = sin (  + 2t ) = cos2t

= 1 -  +  - …………………., for all values of t

=1 - for all values of x

**3. Obtain Taylors series expansion of ex about x = -1.**

**Sol:** Let f(x) = ex

Put x+1 = t  x = t-1

f(x) = ex= et -1 = e-1.et = ] for all values of t

f(x) =] for all values of x

Lagrange’s Form of remainder:



**4).Verify Taylor`s theorem for f(x) = with Lagrange`s form of remainder**

**upto 2 terms in the interval.**

**Sol:** Consider f(x) = in 

(i)  are continuous in

(ii) is differentiable in (0, 1)

Thus f(x) satisfies the conditions of Taylor’s theorem

Now we consider Taylor’s theorem with Lagrange’s form of remainder

 with 0<<1

Here a = 0 and x = 1 , n = p =2 ,b = 1

Now 



And f(1) = 0

From (1) , We have 

Substituting the values, we get 0 =

 = 

 lies in between 0 and 1.

Thus Taylor’s theorem is verified.

**2.6 MACLAURIN ‘S SERIES**

The series is called

**Maclaurin series expansion of**  **degree n about x = 0** assuming that  has successive derivatives of all orders for x  and the remainder after nth term in Lagrange’s form of remainder  , 

**2.6.1:**

**PROBLEMS:**

1). Expand in powers of x

Sol. f(x)=

f(0) = e0 = 1













And so on.

Substituting the values of f(0) , f1(0) , etc ., in the Maclaurin’s series , we obtain

= f(x) = f(0) +







Sol:

We know that the maclaurin`s series expansion ofis given by











Substitute these values in the Maclaurin`s series

\_\_\_\_\_\_\_(1)

**Deduction:**  Differentiate equation (1) w.r.t.x ,we get



**2.7**

**1.Obtain the Maclaurin’s series expansion of coshx**

**Sol :** Given f(x) = coshx

f1(x) =sinhxf(0) = f11(0) = ….f2n(0) = cosh0 = 1

f11(x) =coshx

f111(x) =sinhx

f(0) = f11(0) = ….=f2n(0) = cosh0 = 1

f1(0) = f111(0) …..=f2n+1(0) = sinh0 = 0

Hence by the Maclaurin’s series expansion of coshx is given by

coshx =

= 

**2. Find Maclaurin’s theorem with Lagrange’s form of remainder for f(x) = cosx.**

**Sol:**  Maclaurin’s theorem with Lagrange’s form of remainder is given by



Consider f(x) = cosx



At x=0 ,

Thus f(0) = cos0=1



And

If n is even, coefficient of x will be (-1)n. If n is odd, coefficients of x are all zero.

Substituting these values, we have





**2.7.1**

**TAYLOR`S SERIES FOR A FUNCTION OF TWO VARIABLES:**



is called the *Taylor`s series* expansion of f(x,y) at (a,b) in powers of (x-a) and (y-b).

**NOTE:** If we put a=0 and b=0 in taylor`s series expansion , we get



This is know as *Maclaurin`s series* for function of two variables.

**2.7.2**

**Problem 1:** Expand f(x,y) = x2y+3y-2 in powers of (x-1) and (y+2) upto the terms of

Third degree.

**Sol:** Given f(x,y) = x2y+3y-2 and (x-1) , (y+2)

Here x=a=1 and y=b=-2Now differentiate f(x,y) w.r.to x & y partially, we get 



**9. Practice Quiz**

**1.The value of ‘c’ of the Rolle’s theorem for the function f () = +  in  is**

a) -1 **b) 1**  c) 1.5 d) 1.25

**2.If f (****) is continuous in [ a, b ] , f1 (****) exists for every value of x in ( a, b ) and**

**f (a) = f (b) then there exists at least one value ‘c’ of  in ( a , b ) such that .**

**f1 (c) = \_\_\_**

a) a+b b) a – b c) ab **d) 0**

**3.The value of ‘c’ of Rolle’s theorem for f () =  in (0 , ) is [ ]**

a)  **b) **  c)  d) 

**4.The value of c of Lagrange’s mean value theorem for f () = 2 in [ 1 , 5]is**

a) 2 **b) 3**  c) 3.5 d) 4 [ ]

**5.Lagrange’s mean value for f ( ) = |x| in (-1, 1) is [ ]**

a)discontinuity at x = 0 b) derivative does not exist at x = 0

c) f(x) is not defined properly d) f11(x) ≠ 0 at x = 0

**6. Taylor’s series expansion of f() about = a is [ ]**

**a) f () = f (a) + (-a) f1 (a) +  f 11 (a) +…………**

b) f () = f (a) + f1(a) +  f 11(a ) + ………..

c) f () = f (a) - ( - a ) f 1 ( a ) -  f 11(a ) + ………..

d) none

**7. Maclacuin’s series expansion of f () is [ ]**

**a) f () = f (0) + f1 (0) +  f11 (0) + …………….**

b) f () = f (0) - f1 (0) +  f11 (0) -  f 111  (0) + ………….

c) f () = f (0) + f1 (0) +  f11 (0) +  f 111  (0) + ………….

d) none

**8. sin = \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**  [ ]

a) + +  + + ………………. **b) - +  -+ ……………….**

c ) 1 -  +  -+ ………………. d) none

**9 . If f (0) = 0 , f1 (0) =1, f11 (0) = 1, f111 ( 0) = 1 then the Maclaurin’s expansion of f()**

**is given by**

**a) + + + ……………** b) - -+ ……………

c) + -+ …………… d) +++ …………… [ ]

**10. ** [ ]

**a)Taylor’s theorem with lagranges form of remainder**

b)Cauchy’s theorem with lagranges form of remainder

c)Raman’s theorem with lagranges form of remainder

d) Lagrange’s theorem with lagranges form of remainder

**10.Assignment:**

|  |  |  |  |
| --- | --- | --- | --- |
| **S.No** | **Question** | **BL** | **CO** |
| 1 | Examine Rolle’s theorem for . | **4** | **2** |
| 2 | Examine Lagrange’s mean value theorem for | **4** | **2** |
| 3 | Examine Cauchy mean value theorem for | **4** | **2** |
| 4 | Show that and hence deduce that | **1** | **2** |
| 5 | Examine Taylor’s theorem with Lagrange’s form of remainder up to 2 terms for | **4** | **2** |

**11.Part A- Questions(2-Marks)**

|  |  |  |  |
| --- | --- | --- | --- |
| S.No | Question& Answers | BL | CO |
| **1** | State Rolle’s Theorem.  **Ans**: Let f(x) be a function such that  (i) It is continuous in [a,b]  (ii) It is Differential in (a,b) and  (iii) f(a) = f(b) Then there exists atleast one point ‘c’ in open (a,b) such that f’(c) = 0 | **1** | **2** |
| **2** | Examine whether Rolle’s Theorem can be applied to the following function in the given interval  f(x) =tanx in [0,π].  **Ans:** f(x) is discontinious at x=π/2 as it is not defined there.thus condition (i) of Rolle’s Theorem is not satisfied.Hence we cannot apply Rolle’s Theorem here.  Therefore Rolle’s Theorem is not applicable to f(x) =tanx in [0, π]. | **4** | **2** |
| **3** | Examine whether Rolle’s Theorem can be applied to the function f(x) in [-1,1].  **Ans:** Here f(x) is discontinious at x = 0.Hence Rolle’s Theorem is not applicable to f(x) = in [-1,1]. | **4** | **2** |
| **4** | Examine whether Rolle’s Theorem can be applied to the function f(x) = in [1,3].  **Ans:** Conditions (i) & (ii) are satisfied by f(x).But f (1) ≠ f(3) . Hence Rolle’s Theorem is not applicable f(x) = in [1, 3]. | **4** | **2** |
| **5** | State Lagrange’s Mean value theorem.  **Ans:** Let f(x) be a function such that  (i) It is continuous in [a, b]  (ii) It is Differential in (a, b) and  Then there exists atleast one point ‘c’ in open (a, b) such that  f’(c) = | **1** | **2** |
| **6** | Examine Lagrange’s Mean value theorem for f(x) = in [1, e].  **Ans:** Function is continuous in closed interval [1, e] and derivable in open interval (1,e) .  Hence Lagrange’s Mean value theorem is applicable.  By this theorem there exists a point C in (1, e) such that  f’(c) = =  in (1,e) .Hence Lagrange’s Mean  value theorem is verified. | **4** | **2** |
| **7** | State Cauchy’s Mean Value theorem.  **Ans:** Let f(x) and g(x) be two function defined in[a,b] such that  (i) f(x) and g(x) be continious in [a,b]  (ii) f(x) and g(x) be derivable in (a,b)  (iii) g’(x) ≠0 for all x є (a,b)  Then there exists a point c є (a, b) such that | **1** | **2** |
| **8** | Examine the result of cauchy’s Mean Value theorem for the function sin x and cosx in [a, b]  **Ans:** Here f(x) =sinx and g(x) = cosx  Clearly f(x) and g(x) be continious in [a, b] & derivable in (a, b)  Also f’(x) = cosx and g’(x) = -sin x  By Cauchy’s Mean Value Theorem  There exists a point c є (a, b) such that    ⟹  ⟹ -= ⟹  ⟹ c= | **4** | **2** |
| **9** | Determine the Taylor’s series expansion of ex about x=-1.  **Ans:** The Taylor’s series expansion of f(x) about x = a is given by  f(x)= f(a)+(x-a) (a)+ (a)+……….  Here f(x) = ex & a = -1  (x)= (x) = (x) =(x) = ………… = ex  (-1)= (-1) = (-1) = (-1) =……….= e-1  The Taylor’s series expansion of f(x) about x= -1 is given by  f(x) = e-1 +(x+1) e-1 + e-1 +………. | **2** | **2** |
| **10** | Determine the Maclaurin’s series expansion of cosx.  **Ans:** Let f(x) = cosx  (x)= -sinx, (x)= -cosx, (x)=sinx, (x)=cosx ………….  f(0)=1, (0)= 0, (0)= -1, (0)=0, (0)=1 etc  The Maclaurin’s series of f(x) = cosx is given by  f(x)= f(0)+x (0)+ (0)+ (0)+………………  Cosx= 1- + - +……… | **2** | **2** |

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| **12.Part B-Questions:**   |  |  |  |  | | --- | --- | --- | --- | | **S.No** | **Question** | **BL** | **CO** | | **1** | |  | | --- | | Examine Rolle’s Theorem for | | **4** | **2** | | **2** | |  | | --- | | Determine Taylor’s series of |  |  | | --- | |  | | **2** | **2** | | **3** | Prove that  using Cauchy’s theorem If f( x) = logx and g(x) = x2 in [a, b] with b>a>1 | **5** | **2** | | **4** | |  | | --- | | Examine Taylor’s theorem for f(x) = (1-x)5/2 with Lagrange’s form of  remainder up to 2 terms in the interval [0,1] | | **4** | **2** | | **5** | Examine Rolle’s theorem for f(x) = x (x +3 )  in the interval [ -3 , 0 ] | **4** | **2** | |